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(56) Documents Cited

**WO 94/24579 A1 US 5381151 A US 4152701 A**

(58) Field of Search

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(54) **Ground speed measurement using impulse radar**

(57) A ground speed measuring system for a vehicle comprises at least one impulse radar transmitter for transmitting radio frequency pulses without a carrier wave (carrier-free) and at least one receiver to receive reflected signals from the environment surrounding the vehicle. The received reflections are integrated over a period of time to form a signal at audio frequency having a dominant frequency which is a function of the vehicle speed. The system can include four radar transmitters and receivers located at the corners of the vehicle which provide additional information such as collision warning or function as parking aids.

## VEHICLE GROUND SPEED MEASUREMENT

Field of the Invention

5 The invention relates to a vehicle ground speed measurement device.

The speedometer was one of the first measuring devices required in a motor vehicle and many different ground speed measurement systems have been developed over the years.

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One widely used system uses FMCW radar sensors mounted upon a vehicle which receive reflected signals from the road, the road side and from objects within the vicinity of the vehicle. By measuring the Doppler shift of the received  
15 signal, the true ground speed of the vehicle can be calculated. Such a system can however prove expensive, since the circuitry involved can be costly.

Summary of the Invention

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According to the invention there is provided a ground speed measuring system comprising an impulse radar sensing system including at least one impulse radar transmitter transmitting a series of short radio frequency pulses  
25 without a carrier wave and at least one receiver to receive reflected signals from the environment surrounding the vehicle, an integrator for integrating the received reflections over a time period to form a signal at audio frequency, means to measure the dominant frequency of the  
30 audio signal and to determine current vehicle speed as a function of the dominant frequency.

In this context the term 'impulse radar' is intended to encompass any radar signal of short radio frequency without  
35 a carrier wave, and includes radar sometimes referred to as 'broadband radar'

Because the spectrum of the radiated signal is very broad, the radar cannot be said to operate at a particular frequency. By virtue of transmitting only a short pulse the reflection from the target arrives after a delay  
5 corresponding to the distance from the target. Integration of the signal over a time period can form a signal at audio frequency representative of reflections from the environment.

- 10 The reflected impulse radar waveform has a variable signature depending on the distance and radar cross section of reflectors within the radar field of view. It also has an audio component which has been shown to be variable and related to target velocity. A dominant frequency  
15 characteristic is apparent which is related to current vehicle speed.

The velocity related frequency shift can be used to determine true ground speed of the vehicle by monitoring the  
20 reflection from environment clutter in the road scene. Small radar reflections from the road and the roadside accumulate to give a dominant frequency characteristic of the returned signature.

- 25 Typically the means to determine current vehicle speed uses either digital signal processing techniques or Fast Fourier Transform circuitry. Such processors are commercially available and the choice will be readily apparent to the skilled addressee of the specification.

30 Preferably the received signal from the radar receiver is fed to gating means which sample the signal during a series of predetermined sampling periods, each period corresponding to the time taken for a signal to travel from the  
35 transmitter to a notional range shell and be reflected back to the receiver, such that the presence of a received signal

within the period indicates the presence of an object within the notional range shell.

5 The advantage of using impulse radar for the ground speed measurement is that compact sensors which are easily packaged, are available, thus cutting the cost of the system. The circuitry involved in impulse radar is not expensive and this helps to reduce costs.

10 Moreover impulse radar may be used in a number of applications sensing objects in the vicinity of the vehicle, for example collision warning and parking aids. The sensors used for such applications can also be used for ground speed measurement, thus reducing hardware costs.

15 Preferably the system includes at least two radar transmitters and receivers, and more preferably four radar sensors are mounted, one at each corner of the vehicle. This provides a comprehensive multifunctional system.

20 The choice of circuitry to determine the vehicle speed from the integrated received signal will be apparent to the skilled addressee of the specification.

Claims

1. A ground speed measuring system comprising an impulse radar sensing system including at least one impulse radar transmitter transmitting a series of short radio frequency pulses without a carrier wave and at least one receiver to receive reflected signals from the environment surrounding the vehicle, an integrator for integrating the received reflections over a time period to form a signal at audio frequency, means to measure the dominant frequency of the audio signal and to determine current vehicle speed as a function of the dominant frequency.



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**Patents Act 1977**  
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**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.P): H4D (DRPB, DRPX)

Int CI (Ed.6): G01S 13/02, 13/58, 13/60

Other: Online:- WPI, INSPEC

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	WO 94/24579 A1 (UNIV. CALIFORNIA). See page 2 & page 11, line 21- page 12, line 11.	
A	US 5381151 (BOLES et al). See whole document	
A	US 4152701 (MARA et al). See col. 1, lines 54-59 & col. 2, lines 14-22.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.